

CLAIMS

1. An exhaust treatment device comprising:
 - a substrate comprising catalyst that comprises a precious metal and a solid solution comprising solid solution metals, wherein the solid solution metals comprise yttrium, zirconium, and titanium;
 - a shell disposed around the substrate; and
 - a retention material disposed between the shell and the substrate.
2. The exhaust treatment device of Claim 1, wherein the solid solution further comprises lanthanum.
3. The exhaust treatment device of Claim 2, wherein the lanthanum is present in an amount of about 1 mol% to about 8 mol%, based upon the total weight of the solid solution metals.
4. The exhaust treatment device of Claim 3, wherein the amount of the lanthanum is about 3 mol% to about 7 mol%.
5. The exhaust treatment device of Claim 2, wherein the yttrium, the zirconium, the titanium, and the lanthanum each have an average primary particle size of less than or equal to about 20 nm.
6. The exhaust treatment device of Claim 5, wherein the average primary particle size is less than or equal to about 10 nm.
7. The exhaust treatment device of Claim 1, wherein the solid solution comprises agglomerates having an average major diameter of less than or equal to about 5 micrometers.
8. The exhaust treatment device of Claim 1, wherein the yttrium is present in an amount of about 1 mol% to about 8 mol%, based upon the total weight of the solid solution metals.

9. The exhaust treatment device of Claim 8, wherein the amount of the yttrium is about 3 mol% to about 7 mol%.

10. The exhaust treatment device of Claim 1, wherein the substrate further comprises a sulfate inhibitor.

11. The exhaust treatment device of Claim 10, wherein in the sulfate inhibitor is selected from the group consisting of niobium, vanadium, and a combination combining at least one of the foregoing sulfate inhibitors.

12. The exhaust treatment device of Claim 1, wherein catalyst comprises about 0.05 wt% to about 3 wt% precious metal, based upon the total weight of the catalyst.

13. The exhaust treatment device of Claim 1, wherein substrate has a precious metal loading of about 5 g/ ft³ to about 60 g/ ft³.

14. The exhaust treatment device of Claim 13, wherein in the loading is about 20 g/ft³ to about 40 g/ft³.

15. The exhaust treatment device of Claim 1, wherein precious metal has an average particle size of less than or equal to about 10 nm.

16. The exhaust treatment device of Claim 15, wherein the average precious metal particle size is about 2 nm to about 4 nm.

17. The exhaust treatment device of Claim 1, further comprising a second solid solution comprising titanium and lanthanum, wherein a physical mixture of the solid solution and the second solution is formed.

18. A method of making a catalyst, the method comprising:
forming an organometallic precursor comprising zirconium and titanium
by the etherification of an alcohol; and
decomposing the precursor to form a catalyst comprising a precious
metal and a solid solution.

19. The method of Claim 18, wherein the solid solution further
comprises yttrium and lanthanum.

20. The method of Claim 18, wherein forming the organometallic
precursor further comprises:

reacting a titanium salt with an alcohol to form a titanium alkoxide;
reacting a zirconium salt with an alcohol to form a zirconium alkoxide;
and
mixing the titanium alkoxide and the zirconium alkoxide.

21. The method of Claim 20, wherein forming the organometallic
precursor further comprises:

reacting a yttrium salt with an alcohol to form a yttrium alkoxide;
reacting a lanthanum salt with an alcohol to form a lanthanum alkoxide;
and
mixing the titanium alkoxide, the zirconium alkoxide, lanthanum
alkoxide, and yttrium alkoxide.

22. The method of Claim 18, wherein decomposing the precursor to
form a solid solution further comprises adding water to the precursor.

23. The method of Claim 18, wherein the organometallic precursor
further comprises methacrylic acid.

24. The method of Claim 18, wherein the organometallic precursor
comprises $Zr_2Ti_4O_4[OCH_2CH_2CH_2CH_3][OC(O)CH_3CH_2]_{10}$.

25. The method of Claim 18, wherein the solid solution is formed prior to the introduction of the precious metal.

26. The method of Claim 18, wherein the organometallic precursor comprises a precious metal precursor.

27. The method of Claim 18, further comprising heat treating the catalyst to a temperature of greater than or equal to about 700°C.